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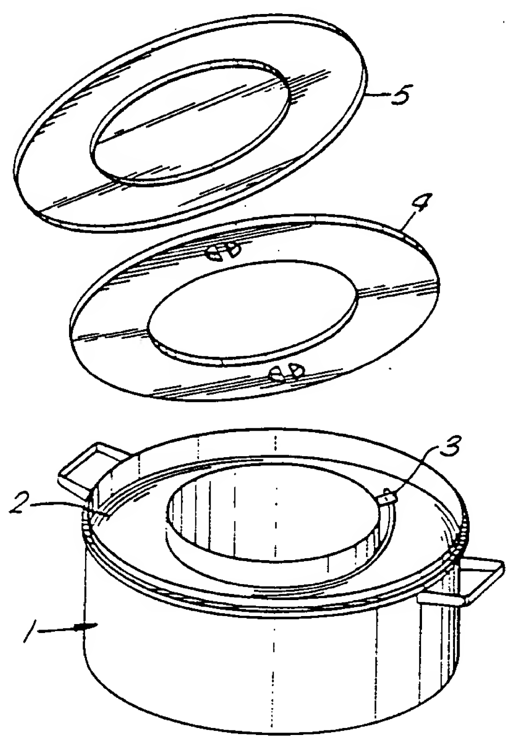


(57) Abstract

A technique for handling filamentary material, especially optical fibre packages, in which the filamentary material (2) is coiled into an annular pan (1) in a series of turns each of which is offset from preceding turns. The turns each contain 360 degrees of torsion which is relieved when the filamentary material is paid out from the pan. A rosetting head for laying the pattern sequence is located in the centre of the annular pan.

FIBRE COILING

This invention relates to coiling and storage of filamentary material and especially of optical fibres and optical fibre packages, and to installation systems for optical fibres.

Published European Patent application 108590 describes an apparatus and method for installing optical fibres in ducts by propelling the fibre along the duct by virtue of viscous drag of an injected gaseous propellant. In such installation the length of duct along which a fibre can be propelled or 'blown' depends upon the number of bends in the duct but typically may be 500 to 800 metres. It is often the case, however, that a much greater length of continuous fibre needs to be installed and in this instance several ducts are placed in series and the additional fibre for subsequent ducts is blown through the first duct and wound on to a drum. Once the fibre for the subsequent ducts has been blown through the first duct it is then blown through the next duct, and so on. However, before the second and subsequent blowing stages can be performed it is necessary to fleet the fibre from the drum to free the end and introduce the fibre to the duct in the correct manner. This means that between each blowing stage there is a delay while the fibre is fleeted and also both reeling and fleeting equipment is required.

It is also found that during fibre blowing installation the fibre package tends to move into the duct at varying speeds. When the fibre package has to be unwound from a reel the inertia of the reel presents significant problems when subject to frequent changes in feed rate, the reel either retarding the fibre or

continuing to unwind at too great a rate giving rise to loose turns. One way of preventing the latter problem is to incorporate a friction brake on the reel, but this has the disadvantage of increasing tension on the fibre package making it more liable to damage should it rub on or be bent around an object in its path.

One of the ojects of the present invention is to provide a system that enables optical fibre to be blown into a duct directly from a coil.

When a filamentary material is laid in a coil, then unless the container into which the filamentary material is laid is rotated each turn of the coil contains 360 degrees of torsion. It has previously been generally recognised as disadvantageous to have containers of filaments with stored torsion: in the case of metal filaments they can be springy and unmanageable and with optical fibres it has been recognised, for example as in EP 0039140, as a potential contributor to entanglement. Various techniques have been devised to prevent this storage of torsion in which the container or platform on to which the coil is laid is rotated in order to reduce or eliminate the torsion. Such a system is described in EP 0039140. However when filamentary material is stored in a coil without torsion, or with less than 360 degrees of torsion per turn, simple pulling of the turns to unwind the coils reintroduces torsion unless the container or platform is again rotated, this time in the opposite direction to that in which it was rotated during coiling. For use in fibre blowing it is undesirable to have torsion in the fibre that is being installed in the duct as this may lead to greater lateral fibre movement and reduce blowing distances. This means that equipment for container rotation would

be required both for winding and unwinding, and especially the latter can be inconventient for in-field use. There is also the disadvantage that rotating the container can suffer from inertial problems the same as those previously mentioned for reels.

Accordingly the invention provides apparatus for forming a coil of filamentary material, the apparatus comprising an annular container with an outer side wall and an inner wall substantially concentric with the outer side wall, and means for distributing the filamentary material into the continer in which the filamentary material is laid in the annular container in a sequence of turns about the inner wall, each turn having 360 degrees of torsion and being offset with respect to adjacent turns and the container is maintained rotationally static.

The invention also provides a container of filamentary material comprising an annular container in which the filamentary material is laid in a sequence of turns about an inner wall of the container, the turns being offset with respect to adjacent turns and each turn having 360 degrees of torsion.

A further aspect of the invention resides in a technique for coiling a filamentary material comprising locating a first section of a continuous filament in a container having an inner side wall located within an outer side wall and passing the filament over a rotatable carrier, rotating the filament carrier about a moveable axis located within the inner wall so that the filament is progressively laid in the container in a sequence of turns about the inner wall, each turn being offset with respect to the preceding turn.

The invention is now described by way of example with reference to the following drawings in which:

Figure 1 is an exploded view of a container including coiled fibre;

Figure 2 shows a rosetting pattern for coiled fibre;

Figure 3 shows a fibre rosetting head in position in a container;

Figure 4 shows an exploded view of a fibre package threaded through a funnel lid for paying out;

Figure 5, 5a and 5b show, respectively, a prior art system for optical fibre storage after production and the system according to the invention;

Figures 6a and 6b show, respectively, a prior art system for fibre coiling during installation and the system according to the invention;

Figures 7a and 7b show alternative fibre blowing methods utilising the invention;

Figure 8 shown a rosetting head threaded to coil optical fibre in a container at an intermediate stage of coiling in a fibre blowing installation;

Figure 9 shows two adjacent stages in a stage-by-stage fibre blowing installation utilising the invention;

Figures 10 to 12 show the stages of freeing the fibre end for a second or subsequent blowing stage, and

Figure 13 shows the last stage of paying out from a container.

In Figure 1 a container in the form of an annular pan 1 contains a coil of optical fibre package 2, the ends of which are marked with tabs 3 (only one shown). The fibre package 2 consists of a plurality of fibres encased in low density coating such as that described in EP 108590, although other suitable filamentary components or packages may also be handled in a way similar to that described herein for optical fibre packages. In particular it is envisaged that non packaged optical fibres may be stored in coils as described herein. The fibre package can be loaded into pans at the point of production and stored, for this purpose a retaining ring 4 and lid 5 are provided. Pans of 500mm external diameter, 300mm internal diameter and 250mm depth may typically hold between 2 and 3.5km of fibre package that has a diameter of 2mm, the length depending upon the packing density.

When the fibre package is to be used it can conveniently be delivered to the point of use in the pan and installed directly from the pan. Coiling fibre package into another pan, for example after installation through the first stage of a multi-stage system, may also be performed conveniently in the field.

Figure 2 shows the preferred rosetting pattern in which the fibre package is laid in the pans by the technique shown in Figure 3. The rosetting pattern is a series of turns each of which is positioned eccentrically with respect to the pan centre and angularly incremented with respect to the previous turn. A rosetting head comprises a constant speed motor 6 which drives a drive

gear 7 and rosetting gear 8 via a slipping clutch 9 that provides constant torque and variable speed. A fibre package feed wheel 10 is provided on the end of an arm 11 which is driven round and offset by the gears to create the rosetting pattern. As each turn of the rosette is laid it receives 360 degrees of torsion as a consequence of being fed in by the rotating arm. The fibre package is thus stored with torsion in each turn. The rosetting head and motor are designed so that the motor housing fits removably within the centre ring of the pan annulus with the arm 11 mounted above the level of the sides. To protect the fibre package and mechanism a lid incorporating a funnel or guide is placed over the pan. In Figure 3 the lid has a central funnel 12 and a guide extension 13, and is supported by a spacer ring 14. This whole lid assembly may be made integrally or in separate parts, but it is convenient for the lid 5 to incorporate a funnel 12 and be reversible so that for storage the lid is located with the funnel projecting inwardly into the centre of the pan annulus, the lid being inverted to the position shown in Figure 3 with the funnel outwardly for paying out and winding. In the case of paying out, the spacer ring 14 is not necessary because the rosetting head is removed and the fibre package is simply pulled out of the pan. Figure 4 shows the fibre package 2 threaded through a funnel lid, following this threading the lid is positioned on the pan and the fibre package pulled out, for example by blowing installation.

Figure 5 compares the prior art system (Figure 5a) with the system of coiling using the rosetting head and pans (Figure 5b). Figure 6a shows the prior art system of paying out an intermediate stage of a multi-stage installation process, this stage having been preceded by a winding process for transferring the fibre package

from a take up drum to a fleeting machine. Figure 6b shows the relative simplicity of the rosetting head and pan method.

During fibre blowing installations the fibre package 2 is fed directly from the pan to the blowing head. Two systems are shown in Figure 7 where the continuous length of fibre package to be installed is greater than twice the maximum blowing distance, which in general means installations exceeding 1000 metres. In Figure 7a tandem blowing is utilised, the fibre package being fed into a first blowing head 15 and blown for, say 500 metres at which point the duct 16 is vented and the fibre package proceeds directly into another blowing head 15'. The installation depicted in Figure 7b is interrupted after each 500 metres or so of duct and the fibre package is rosetted into a pan 1 as it emerges from the far end of the duct 16.

Figure 8 shows how the pan and rosetting head are set up after the leading end of the fibre has been received at the far end of the duct 16. While the head is set up it will usually be necessary to suspend blowing through the duct 16. After setting up the head the leading end of the fibre is flagged and placed in the bottom of the tray, the rosetting commenced and the blowing through the duct recommenced. Figure 9 illustrates two adjacent stages 17 and 18 during a multi-stage installation, the fibre package being paid out from stage 17 and wound in at stage 18. When this is completed stage 18 will be paid out to the subsequent stage after the leading end has been recovered as described later.

Two stages (usually the first two) in an installation may be achieved without a winding stage even for non tandem blowing. In this instance the pan of fibre package is located between the first and second duct stages. The uppermost end of the fibre package is paid out and blown along the first duct stage (which may be the end of the installation or be a winding stage). When the requisite length has been blown through the first duct the blowing operation is stopped and the second end of the fibre package (which is at the bottom of the pan) is located and that end is blown through the second duct (again to an end of the installation or a winding stage). The operation of locating the second (bottom) end of the fibre package is the same as for locating the leading end after a winding stage and is described next.

Figures 10, 11 and 12 illustrate a sequence of steps to free the leading end of a fibre package that is located at the bottom of the wound fibre package in a pan having a fixed bottom. One end of the fibre package is at a remote location of the installation either having been blown there from the top of the pan or having been retained at the remote location while the remainder of the fibre package was blown through a duct. Thus the continuous length of fibre package 2 extends from duct 16, through a funnel lid 5 to the coil in the pan. The lid is removed from the tray and carefully laid to one side and the rosetting head(if winding has just taken place) is carefully removed by freeing the fibre package from the feed reel. Several spacer lugs 19, for stability at least three, are then located on the sides of the pan, and a second empty pan located upside down on top of the lugs 19. The pans and lug assembly are then inverted to decant the coiled fibre package into the empty pan so that the end

of the fibre previously underneath is now exposed on the top of the coil. This end is then fed through the funnel lid and into the blowing head for the next stage. It is found useful to lightly tape the fibre package extending from duct 16 to the side of the pan at the location referenced 20. The pan spacers are removed and the funnel lid replaced.

It will be realised that the pan spacers 19 serve to prevent the fibre package that hangs over the edge of the pan from being squashed between the pans during the inversion procedure. The lugs may be separate components or be attached to the pans, and they may be modified to function also as catches or clips for the lid. Alternative ways of preventing the fibre package from being squashed can be used. For example, a slot for the fibre package may be provided in the side wall of the pans or a tubular spacer may be inserted into the centre of the pans. The tubular spacer is particularly preferred because it enables free passsage for the fibre all around the outside of the pan. A suitable form of tubular spacer comprises a tube of external diameter slightly less than the internal diameter of the inner wall of the pan 1 so that it will fit within the inner walls of the upper and lower pans, a central portion of the tubular spacer having an enlarged diameter so that it will not enter within the inner walls and holds the pans apart.

Figure 13 shows the last section of fibre package emerging from the top of the funnel lid when both ends of the package are installed in ducts. Pulling the turns directly out of the pan causes the 360 degrees torsion in each turn to be relieved so that the last turn pulls out freely and the installed fibre package is free of torsion. The taping of the fibre package at

point 20 should be sufficiently light for the fibre package to pull free without damage. In the event that the taping is too strong sensors on the blowing head interrupt the blowing so that the lid can be lifted and the tape removed.

Although the winding arrangement has been described with regard to storage after production and during blowing operations, the technique is also applicable as an alternative to reeling on other installation procedures, and the filament need not be a fibre blowing package. A further advantage of the invention is that in paying out from a pan, the rate of paying out closely follows the demand rate and therefore the problems encountered with reel inertia or moving containers do not occur. The filament is therefore relatively free from tension and in the event of the filament being a fibre, this makes it far less liable to damage.

In the event that the continuous length of filament being handled is greater than that which can be wound into a single pan (which can of course be provided in a variety of sizes) a continuation pan can be loaded in the same way as described with respect to a single pan, except that there is no free end to lay in the bottom of the pan and a free passage for the length of fibre package extending from the base of the continuation pan to the previous pan is required. This free passage may be provided by taping the fibre package to the side of the pan and/or lid out of the way of the rosetting head.

When a length of fibre is wound into two (or more) adjacent pans in this way it is possible to simultaneously access both ends of the fibre by freeing

(through inversion) the end of the fibre laid at the base of the first pan, the second being available at the top of the second end (or last filled) pan. Each end may then be introduced to a respective duct and blown in, thereby enabling simultaneous installation of two adjacent stages of ducting. Starting at a central location and utilising tandem blowing (booster injection of compressed gas, preferably preceded by venting) this enables installation of several kilometres of fibre in a single operation.

Instead of decanting wound fibre from one pan to another it is also possible to provide a pan with an openable base, thus enabling inversion and access to the covered end without decanting: such a pan could, in some instances and with suitable modification, be mounted with the turns in a vertical plane and accessed from each side for paying out.

With the preferred rosetting pattern and a 2mm fibre package it is preferred to load the pans with the offset increment between turns being such that 100 turns provides a 360 degrees repetition cycle. This is relatively loose packing but is less likely to result in tangles on rapid paying out, which can occur if a turn that is being paid out lifts an adjacent turn. Maximum packing density is of the order of 200 turns per 360 degrees repetition cycle.

Although the technique and apparatus has been described in relation to optical fibre packages and fibre blowing it is applicable in other situations. One particular advantage of the invention is that the ends of the filament or line are stationary and thus they can be connected to a transmission system so that the line can

be monitored, for example, during paying out or communication maintained to remote moving apparatus to which a line is being paid out or wound in. This is particularly relevant for optical fibre systems where communication through moving terminals via split rings is not possible.

CLAIMS

1 Apparatus for forming a coil of filamentary material (2), the apparatus comprising an annular container (1) with an outer side wall and an inner wall substantially concentric with the outer side wall and means (10) for distributing the filamentary material into the container in which the filamentary material is laid in the annular container in a sequence of turns about the inner wall, each turn having 360 degrees of torsion and being offset with respect to adjacent turns and the container is maintained rotationally static.

2 Apparatus according to claim 1 in which the means for distributing comprises a rotatable filament carrier mounted within the inner wall.

3 Apparatus according to claim 1 or claim 2 in which the axis about which the filament carrier rotates is progressively moved so that the turns are laid eccentrically and adjacent turns have their centres offset.

4 Apparatus according to claim 3 in which the filament carrier is mounted on a series of gears.

5 Apparatus according to any preceding claim in which the turns are circular.

6 A container of filamentary material (2) comprising an annular container (1) in which the filamentary material is laid in a sequence of turns about an inner wall of the container, the turns being offset with respect to adjacent turns and each turn having 360 degrees of torsion.

7 A container according to claim 6 in which the turns comprise a sequence of respectively eccentric circles.

8 A technique for coiling a filamentary material (2) comprising locating a first section of a continuous filament in a container (1) having an inner side wall located within an outer side wall and passing the filament over rotatable carrier, rotating the filament carrier about a movable axis located within the inner wall so that the filament is progressively laid in the container in a sequence of turns about the inner wall, each turn being offset with respect to the preceding turn and containing 360 degrees of torsion.

9 A technique according to claim 8 in which the turns are a sequence of respectively eccentric circles.

10 A system for installation of optical fibre transmission lines, the system comprising at least one container (1) of coiled optical fibre package (2) the container having a substantially annular configuration with an outer side wall and a substantially concentric inner wall and having the fibre package coiled around the inner wall in a sequence of turns each turn having 360 degrees of torsion and being offset from adjacent turns, an end of the fibre package being fed into an installation duct (16) from the container and advanced through the duct by fluid drag with the container of fibre package being maintained rotationally static.

11 A system according to claim 10 in which excess fibre package emerging from the remote end of the duct from the installation end is coiled into an annular container in a sequence of turns each turn having 360 degrees of torsion and being offset with respect to

adjacent turns, the annular container being maintained rotationally static while the fibre package is coiled into the container along a helical path.

12 A system according to claim 10 or claim 11 in which a fibre package end at the bottom of one of said containers of coiled fibre package is released and introduced to an installation duct and advanced therethrough by fluid drag with fibre package turns being pulled from the coil without rotation of the container.

13 A system according to claim 12 in which the fibre end at the bottom is released by inverting the container to invert the coil of fibre package into another container.

14 A system according to claim 12 in which the fibre end at the bottom is released by removal of the base of the container.

15 A system according to claim 12, 13 or 14 in which a continuous length of fibre package is installed into two installation ducts extending respectively in two directions, a first end of the fibre package being installed from the top of an annular container and the second end being installed after release from the bottom of an annular container.

16 A system according to any of claims 10 to 15 in which the fibre package is advanced utilising tandem blowing.

Fig.1.

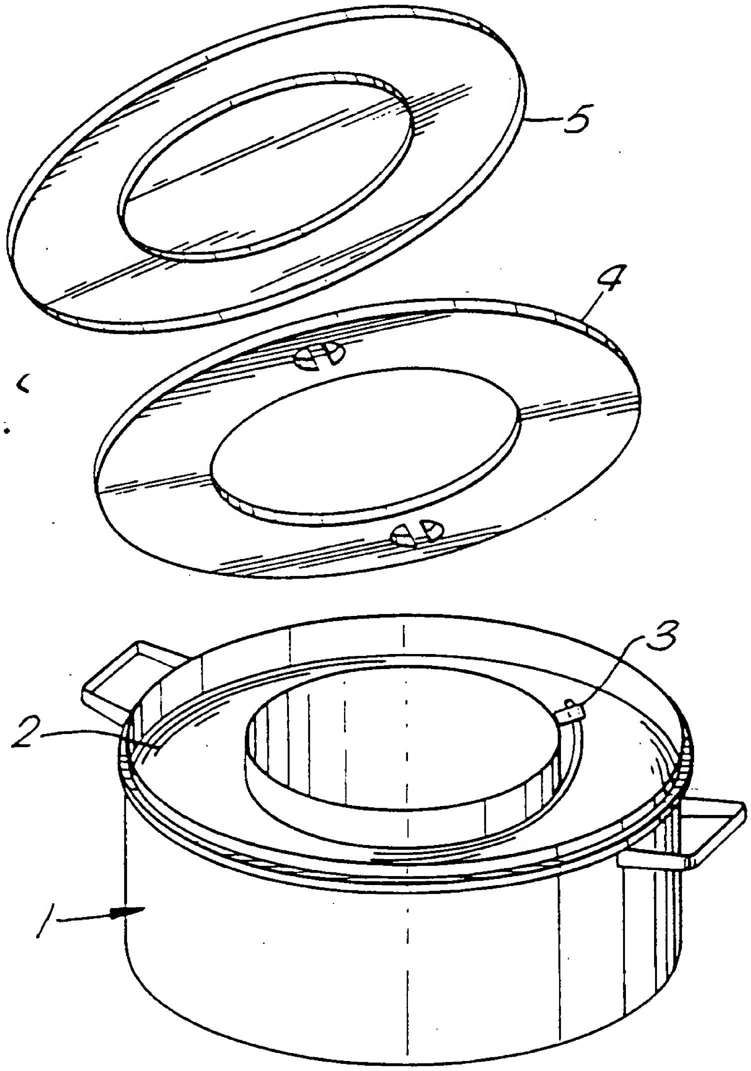
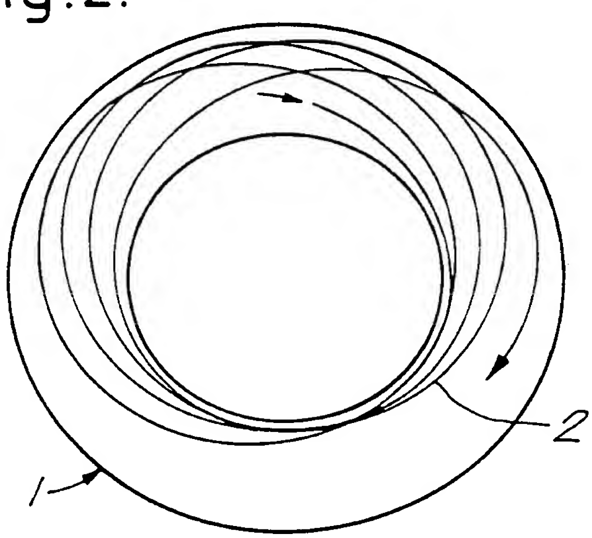


Fig.2.



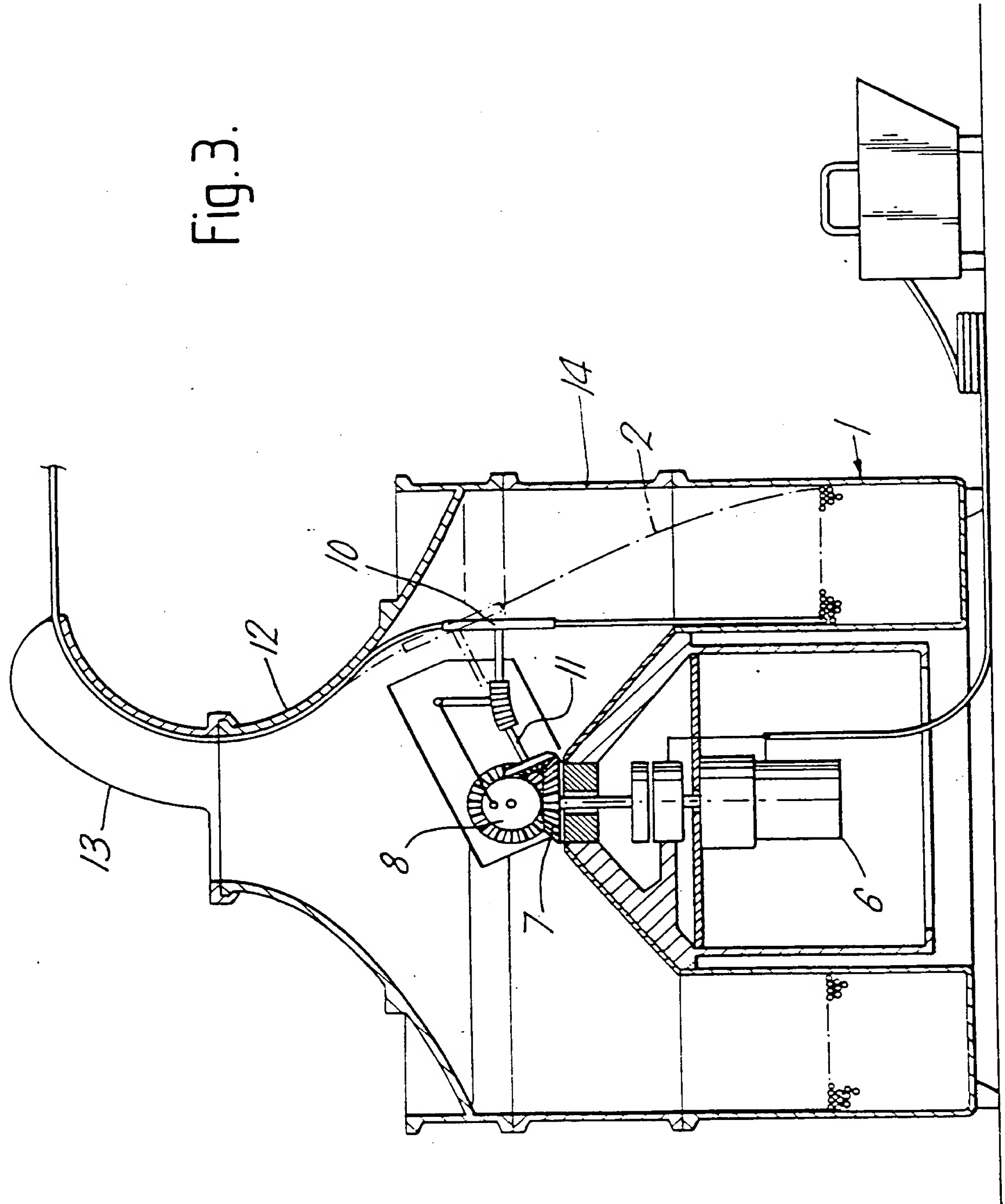
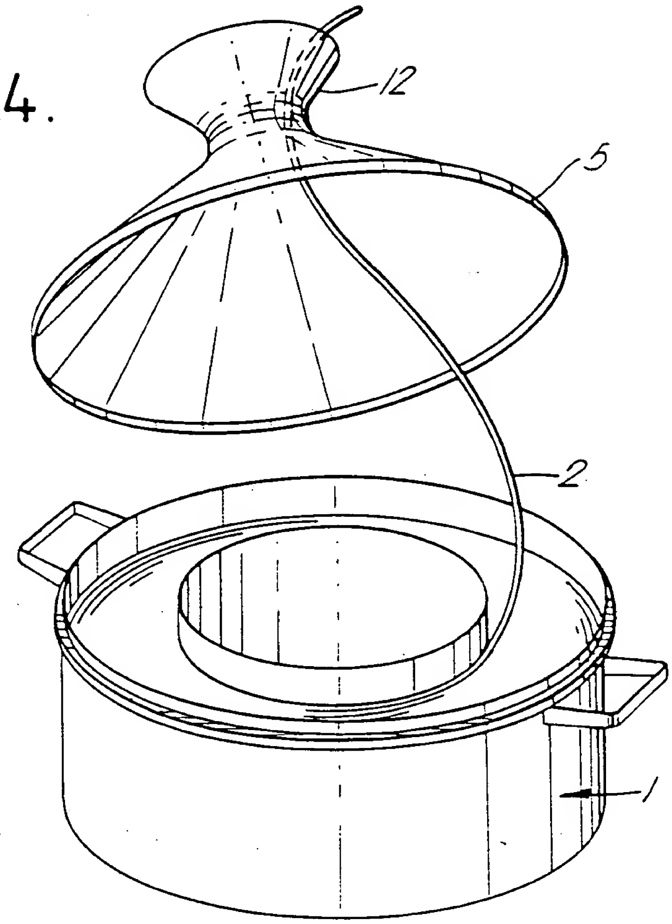


Fig.3.

Fig.4.


12
5
2
1

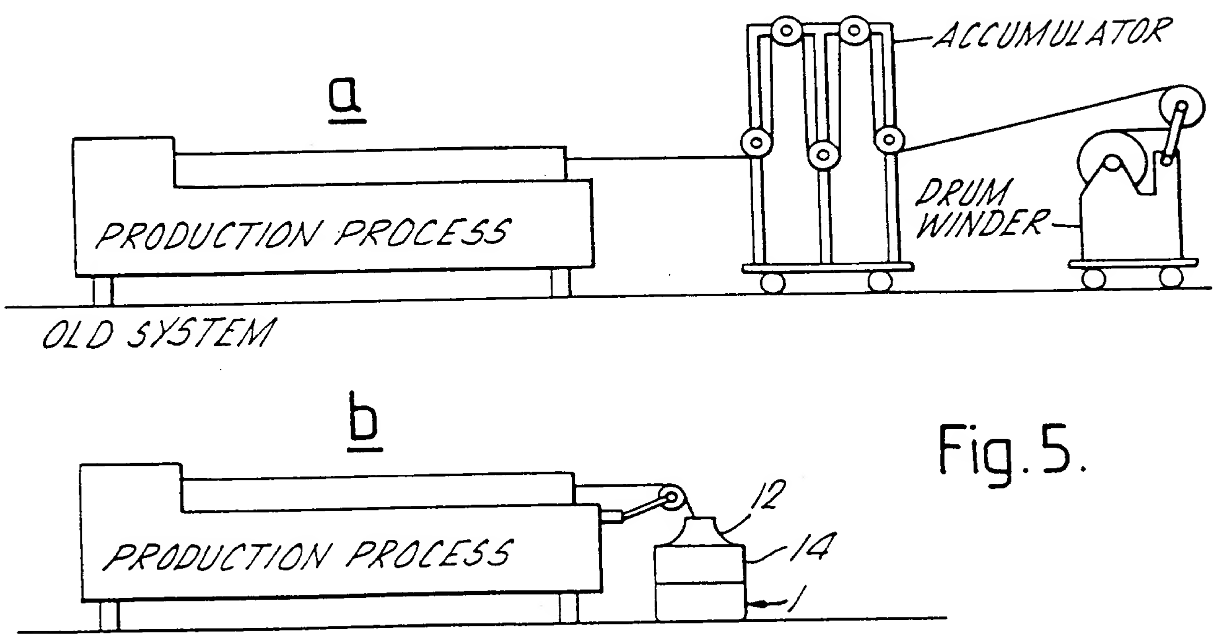

a
ACCUMULATOR
PRODUCTION PROCESS
DRUM WINDER
OLD SYSTEM
b
PRODUCTION PROCESS
12
14
1

Fig. 5.

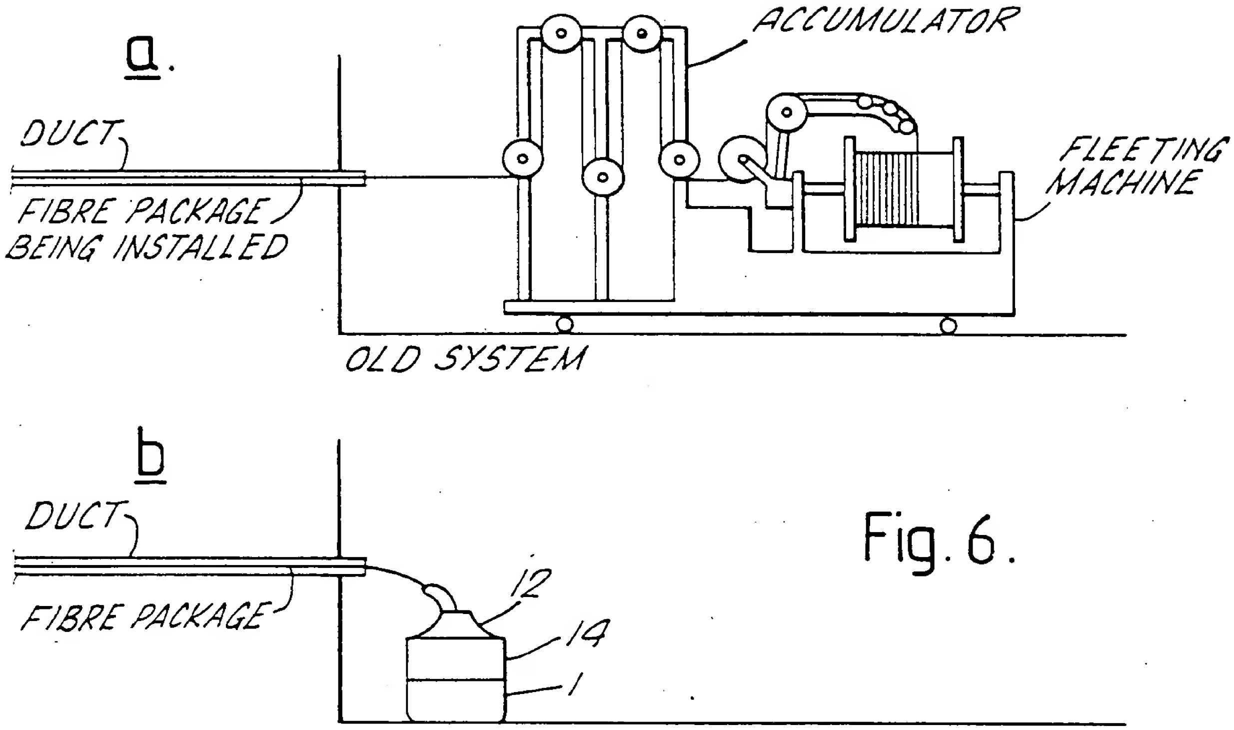

a.
DUCT
FIBRE PACKAGE BEING INSTALLED
ACCUMULATOR
FLEETING MACHINE
OLD SYSTEM
b
DUCT
FIBRE PACKAGE
12
14
1

Fig. 6.

Fig. 7.

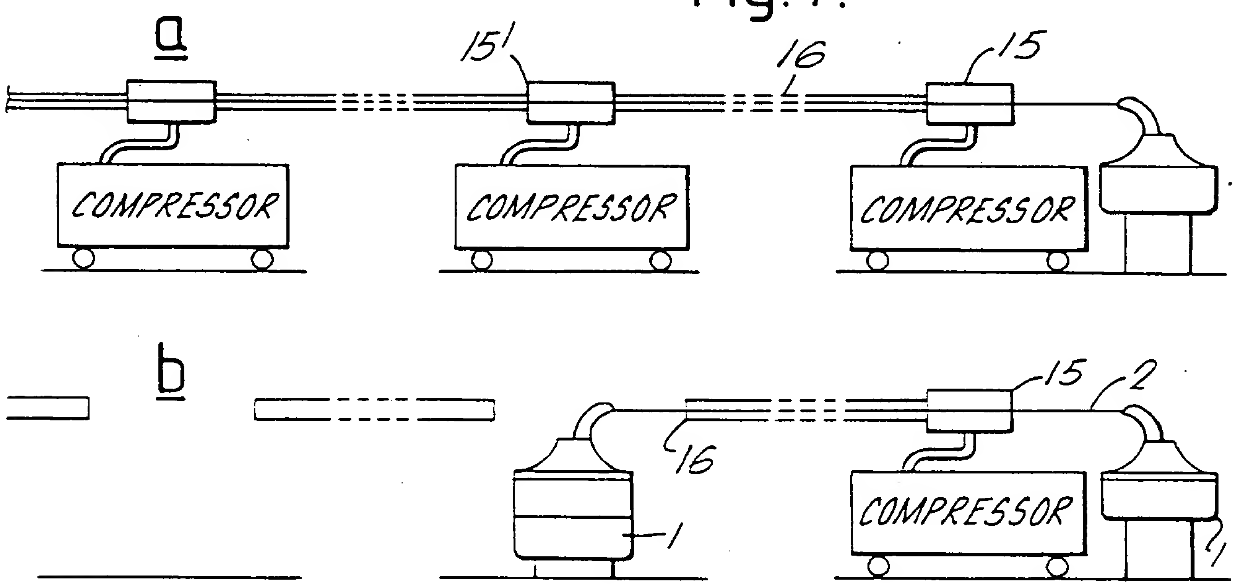

a
15'
16
15
COMPRESSOR
COMPRESSOR
COMPRESSOR
b
15
2
16
1
COMPRESSOR
1

Fig.8.

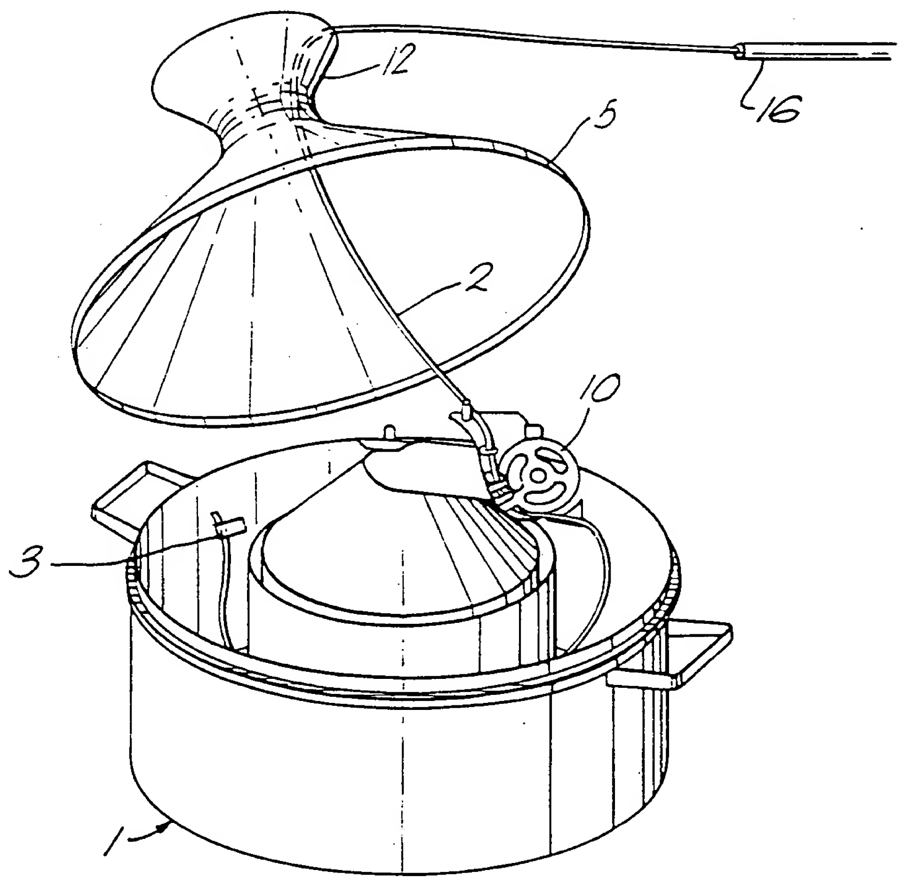


Fig.9.

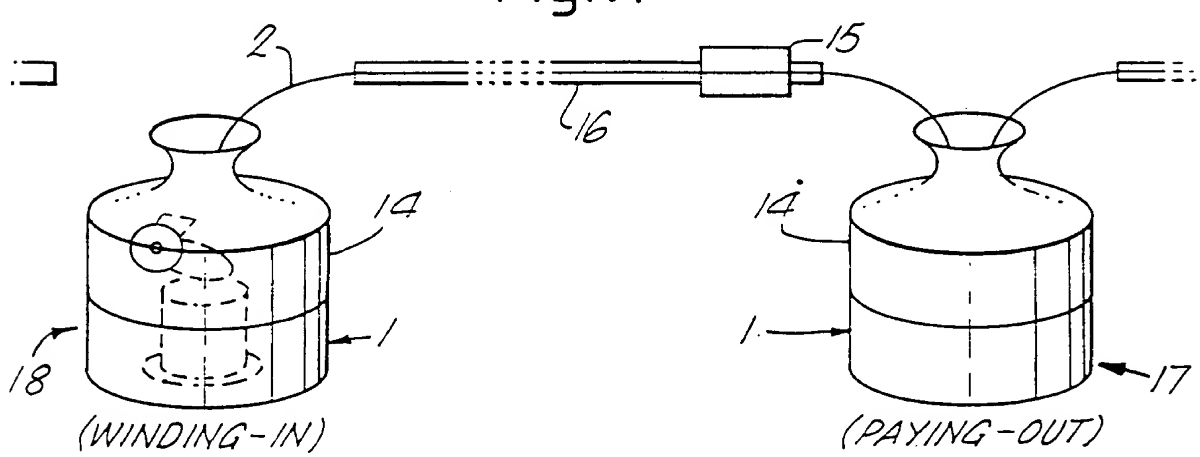


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Fig. 10.

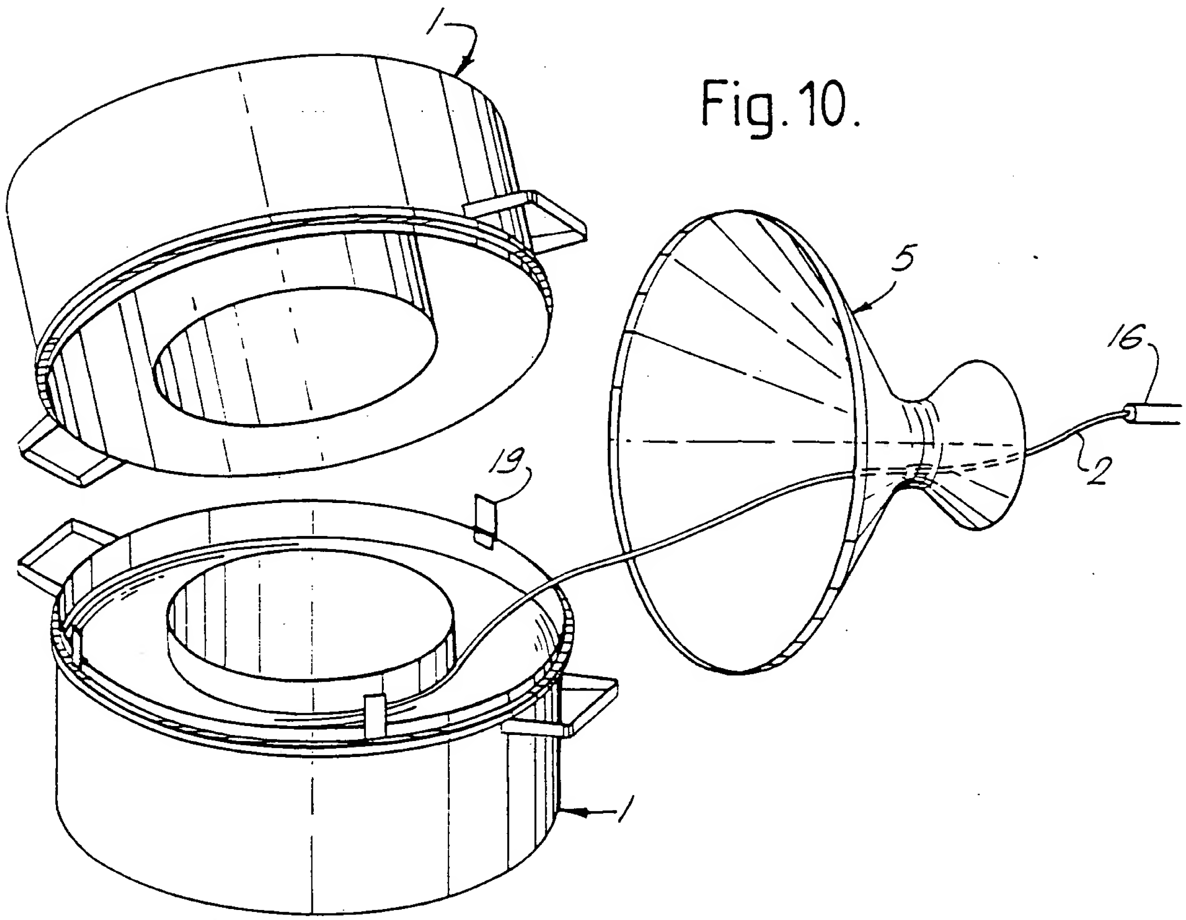
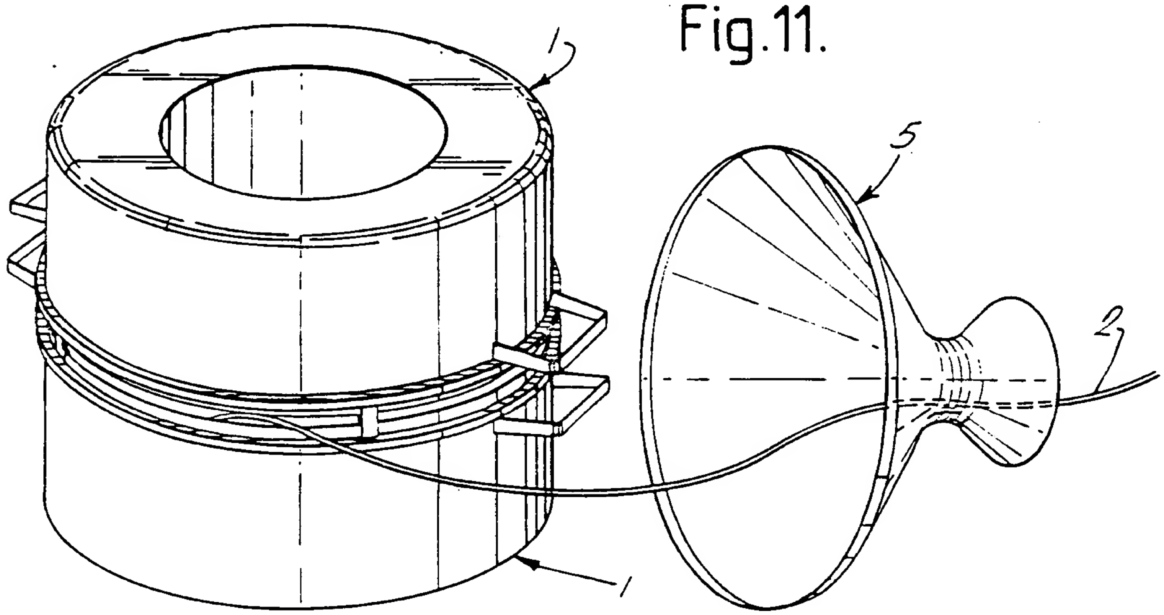


Fig. 11.



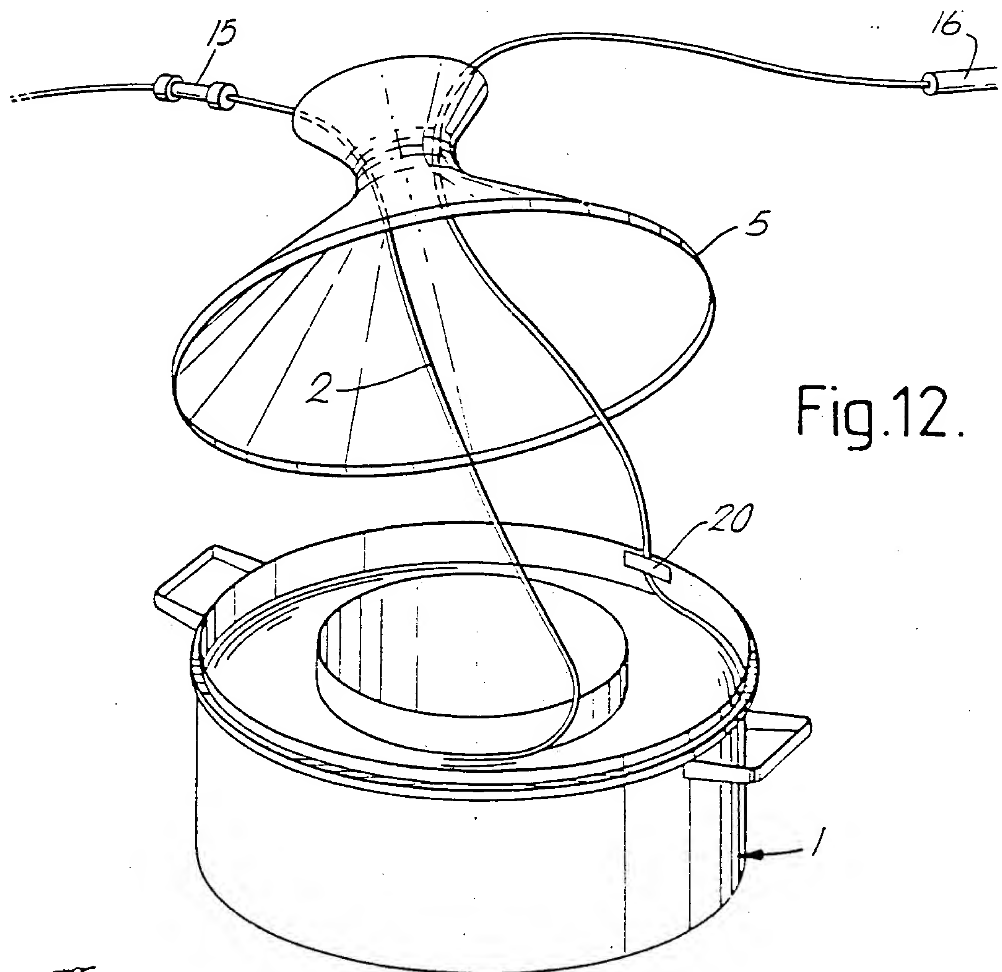


Fig.12.

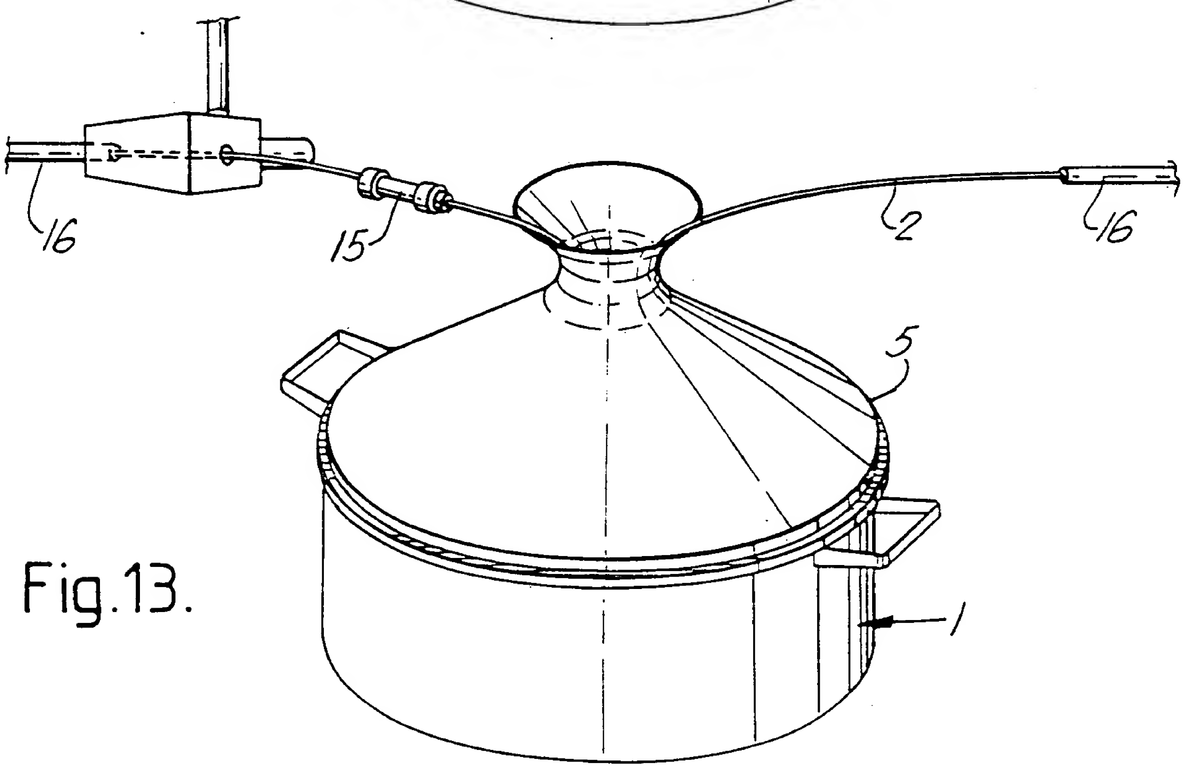


Fig.13.